Research Article

EFFECT OF PLANTING MEDIA (RICE HUSK AND COCO PEAT) ON THE UPTAKE OF CADMIUM AND SOME MICRONUTRIENTS IN CHILLI (*CAPSICUM ANNUM L.*)

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ABSTRACT

The ecological effects of heavy metals or trace elements in soils are closely related to their contents and speciation in the soil. They play a significant role in the metabolic pathways throughout the growth and development of plants when presented in required concentration. In this study the effect of rice husk and coco peat media on the cadmium uptake by chilli plant (*Capsicum annum L.*) was investigated. The experiment was conducted in complete randomized block design (RBD) comprising of three replications. Various concentrations of Cd were dosed to the media once after one week of transplantation. All the required agricultural practices were applied uniformly until harvesting. Cd accumulation in roots, shoots and fruits were analyzed during vegetative, flowering and maturity stages, using atomic absorption spectrophotometric analysis (AAS). Results showed that both planting media exhibited higher accumulation of Cd in roots and shoots at the vegetative stage. The accumulated amount was found significantly dependent on the Cd dose injected to the media. Consequently, micronutrients contents and plant growth were also affected. The accumulated Cd in fruits was found slightly less in rice husk than coco peat media and above the prescribed safety limits recommended by FAO and WHO. Rice husk has higher impact on the microneutrients absorption than coco peat media. In this study, root length, plant hight, dry weight and fruits showed small differences among growing media.

Keywords: *Coco peat, Cadmium, Chilli, Planting media, Rice husk*

1. Introduction

Heavy metals are classified as the most dangerous pollutants that affect living organisms even at low concentrations. They cause many problems to the human body such as problems in the nerve system, kidney and liver damage, cancers of various body organs and low birth weight, depending on the amount consumed [1]. Cadmium (Cd) is one of the most common and

toxic heavy metals in the environment. The main sources of cadmium toxicity are mines, paints, atmospheric deposition and fertilizers [1,2]. It accumulates in the human body by days. The average amount of Cd that accumulates in the human body at age 50 is approximately 30 mg [3]. High dose of cadmium can lead to the lung diseases, lung cancer, high blood pressure, prostate cancer, heart disease and anemia [3-4].

It can also replace calcium in the bones causing fragility and distortions for bones.

Coco peat is an organic material made from coconut peel. The long fibers of coconut are used in the manufacturing of brushes, spinning, car seat and mattress stuffing, while, short fibers (2 mm and less) and the dust are further cut, crushed and washed to produce a new product suitable to use as a planting medium. Rice husk is another important agricultural waste material used as a planting medium. South and southwest Asian countries produce about 90% of the world rice production. 20% of the rice by weight is husk. Rice husk is considered as a good planting medium due to its light weight and good chemical and physical properties [5]. Chilli is one of the most important crops which is planted worldwide because it contains the important vitamins, minerals and proteins needed for human body and also as food flavors [6]. It has some medical benefits, i.e. it can help the human body for the prevention of some diseases such as heart diseases, obesity and different types of cancers [6,7]. Chilli plant like other plants could be affected by the heavy metals when they accumulate in different plant parts. Trace amounts of Cd in chilli can lead to a reduction in plant growth and nutritional value of chilli fruits [8]. This study was aimed to investigate the effect of planting media on the absorption of Cd by chilli plant (*Capsicum annuum L.*) and its effect on the uptake of micronutrients and plant performance.

2. Material and Methods

2.2 Plant, media and fertilizer materials

Seeds of chilli Kulai 568 (*Capsicum annuum L.*) were provided from the local market. Rice husk and Coco peat planting media and fertilizers (urea and amino acid) were supplied from the agricultural research station, Relau, Penang, Malaysia.

2.3 Experimental

2.3.1 Location and Design of the experiment.

To study the effect of rice husk and coco peat planting media on the accumulation of cadmium in chili plant, a research study was carried out at the above mentioned agriculture research station during the year 2012. The experiment was laid out in randomized block design (RBD) [9].

2.3.2 Cadmium doses

To study the effect of planting media on the uptake of cadmium by chilli plants, plants were inoculated by three concentrations of Cd^{2+} (10, 20 and 30 ppm) following a reported procedure [9,10]. Doses of cadmium were applied after transplanting. A fourth sample without any addition of Cd was used as a control. Three replicate plants were used in each treatment.

2.3.3 Sample preparation

A 0.1g of the sample was digested with a mixture of sulphuric acid, nitric acid and hydrogen peroxide (1:3:3) as prescribed by Saison, *et al.* [11]. The beakers were brought to near dryness on a water bath. The residue was filtered and the filtrate was topped up with double distilled water to 20 mL in a volumetric flask. Metal ions concentrations in the samples were then determined using atomic spectrophotometric analysis (AAS), Model, Perkin Elmer Analyst 200.

2.3.4 Statistical analysis.

The experimental data was assessed by one way analysis of variance (ANOVA) using SPSS Package (19). Thereafter, Kruskal-Wallis test was used to detect differences between treatments for each measured parameter [12]. All values were presented as means ($\pm$) standard deviation (S.D.). The significance level was set at $P < 0.05$.

3. Results and Discussions

In the present study, the effect of rice husk and coco peat planting media on the amount of cadmium that accumulated in three parts of chilli plant, i.e. roots, shoots and fruits at various plant growing stages were investigated.

3.1 Accumulation of Cd in chilli roots.

The effect of media on the total amount of Cd that accumulated in the roots of chilli plant was found in the range from 0.06-0.24 and 0.07-0.19 ppm along with the plant growth in both growing media, respectively. Data pertaining to Cd accumulation in roots and shoots are displayed in [Tables 1 and 2](#). The uptake of Cd by roots at the vegetative stage was slightly higher in plants that grown in coco peat than that in rice husk media. The accumulated amount was found dependent on the concentration of Cd in pots. This finding indicated that the chilli roots have the potential ability to absorb Cd from contaminated planting media when compared with control samples (~0.08 ppm). This agrees well with the previous reports where fertilizers such as phosphate and urea have a highly effect on the Cd desorption by rice plant [8,13]. However, the amount of Cd taken up by the control plant in the present study could be from atmospheric emission, used fertilizers or from the all together.

3.2. Accumulation of Cd in the chilli shoots.

The concentration of Cd was significantly increased at all plant growth stages in both media ([Tables 1 and 2](#)). With the exception of the 30 ppm treatment (vegetative stage in coco peat media), flowering stage exhibited the highest accumulation of Cd at various treatments in both media. Alternatively, the amount of Cd in shoots was significantly decreased at maturity stage (0.09 ppm) comparing with that accumulated at the flowering stage (0.18 ppm) in rice husk media. Results showed that both

studied media have different effect on Cd accumulation in chilli shoots. As the case for the roots, analysis also confirmed the correlation between the applied concentrations of Cd and that accumulated in the plant shoots in both media. These results support the findings of Hegde [14] and Rajshree [15] where higher concentrations of Cd and other micronutrients were found at the flowering stage of chilli plants (*Capsicum annuum*).

3.3. Accumulation of Cd ion in chilli fruits.

The data related to chilli fruits is presented in Fig-1. During the investigation of the accumulated level of Cd in chilli fruits in both media, no significant change in the total amount of Cd was observed. Approximately 0.1 ppm Cd was the highest amount that could be accumulated in chilli fruits regardless of the dose or growing media. The low concentration of heavy metals in fruits could be due to their accumulations in other plant parts [16]. Further investigations showed a positive correlation between the concentration of Cd in the media and that accumulated in the fruits. Clear shift in the total amount of Cd that accumulated in fruits was observed upon the addition of Cd to the planting media (control). The amount of Cd was increased from 0.05 ppm and 0.07 ppm (control) to approximately 0.1 ppm after the treatment in both media, respectively. However, the accumulated amount of Cd in chilli fruits (~0.1 ppm) above the safety limit suggested by FAO and WHO, 2001 (0.05 ppm) [17]. Askok, *et. al.*, [18] observed similar results about the accumulation of Cd in chilli fruits collected from local markets at Anand, India.

3.4. Effect of Cd concentration on the uptake of micronutrients in chilli fruits.

The effect of the absorbed Cd on the total amount of micronutrients in chilli fruits has also

been investigated. Prior to the media treatment, Cd concentration in both media (blank) was first analyzed. Table 3 presents the heavy metal contents of both media. For the same reason mentioned above, only 30 ppm dose was selected (Table 4). The statistical analysis indicates that both media have significant effect on the micronutrients absorption by the chilli plant. The absorption of Mg, Ca, and Fe is significantly decreased, while a minor effect on Zn and Mn was observed in both media. Although, rice husk media contains higher concentrations of micronutrients (Table 3), less concentrations of these metal ions were absorbed by the chili plant. These findings revealed the higher impact of rice husk media on the absorption of micronutrients by chilli plant in the presence higher doses of Cd. These results support the findings of Roya *et al.*, [19] where higher concentrations of Cd, Pb, Ni significantly affected the uptake of micronutrients in barley plant. Therefore, even though the total amount of Cd in chilli fruits was still within the safety limit, its presence is highly affected the nutritional value of chilli fruit.

3.5. Effect of Cd accumulation on the dry matter weight.

Planting media is known to have large effect on the plant growth characteristics [20,21]. Roots and shoots dry weight did not significantly affected by the addition of Cd. Nevertheless, variation in roots dry weight between treatments at different plant growth stages was observed in both media. Means for the dry weight at each growing stage indicates that the maximum dry weight per plant was calculated in coco peat media. The results were similar to that of Gabriella, *et al.* [22], Lucia, *et al.* [23] and Awotoye, *et al.* [24]. They studied the effect of heavy metal ions (As, Cd, Pb, Cu and Zn)

present in the planting media on roots and shoots dry weight of radish and sunflower plants.

4.6. Effect of Cd accumulation on the growth parameter.

3.6.1. Root length.

The effect of Cd on the physical growth of the chilli plant was investigated. Results showed that the root length of plants was not affected by Cd treatments in both media (Tables 1, 2). No significant variations were observed at all growing stages. A similar observation was reported by other groups [10,24].

3.6.2 Plant height

Results showed that the plant height was not varied between treatments in various plant growing stages with the exception of the maturity stage (Tables 1, 2) in both media. An indirect correlation between treatments and the plant height at maturity stage was observed, i.e.

Figure 1. Effect of planting media on Cd uptake in chilli fruits *Capsicum annum L.*

Table 1: Effect of rice husk media on the growth characteristics and Cd uptake of chilli plant *Capsicum annum* L.

Growth Stage	Treatment (ppm)	Root Length (cm)	Plant Height (cm)	Dry Weight (g)		Accumulated Cd (ppm)	
				Roots	Shoots	Roots	Shoots
Vegetative	Control	20.0 (2.0)	32.0 (2.6)	4.8 (0.6)	13.0 (1.6)	0.09 (0.02)	0.08 (0.01)
	10	18.3 (5.1)	28.0 (8.9)	4.7 (0.1)	13.8 (1.5)	0.14 (0.30)	0.12 (0.04)
	20	19.0 (4.6)	27.0 (7.9)	4.4 (0.2)	11.7 (1.1)	0.17 (0.66)	0.10 (0.05)
	30	15.6 (1.5)	23.3 (6.8)	4.6 (1.0)	11.6 (0.3)	0.18 (0.04)	0.12 (0.02)
Flowering	Control	24.0 (5.0)	46.3 (8.0)	19.4 (1.7)	27.3 (3.9)	0.08 (0.03)	0.04 (0.01)
	10	24.0 (5.6)	38.6 (16.2)	14.2 (6.2)	28.0 (5.0)	0.12 (0.03)	0.11 (0.01)
	20	30.3 (11.2)	40.3 (13.9)	17.3 (3.2)	25.4 (8.7)	0.18 (0.04)	0.12 (0.01)
	30	21.6 (2.1)	45.6 (15.7)	20.3 (1.7)	30.1 (6.9)	0.19 (0.01)	0.18 (0.01)
Maturity	Control	22.6 (3.1)	70.0 (9.5)	13.3 (1.5)	52.2 (18.2)	0.08 (0.01)	0.06 (0.01)
	10	24.3 (6.0)	63.0 (12.1)	13.1 (6.5)	35.8 (5.4)	0.10 (0.02)	0.07 (0.01)
	20	23.0 (6.6)	60.6 (6.7)	17.2 (6.6)	44.7 (19.0)	0.10 (0.01)	0.09 (0.01)
	30	28.6 (6.7)	57.3 (0.6)	15.0 (5.3)	42.7 (8.0)	0.14 (0.02)	0.09 (0.01)

The values in parenthesis are the standard deviation ($\pm$ SD). All values are significantly different at $P>0.05$ level .

Table 2: Effect of coco peat media on the growth characteristics and Cd uptake of chilli plant *Capsicum annum* L.

Growth Stage	Treatment (ppm)	Root Length (cm)	Plant Height (cm)	Dry Weight (g)		Accumulated Cd (ppm)	
				Roots	Shoots	Roots	Shoots
Vegetative	Control	16.6 (2.5)	30.6 (1.5)	5.8 (0.4)	12.1 (1.0)	0.07 (0.01)	0.05 (0.01)
	10	14.0 (3.5)	30.6 (3.2)	4.3 (0.2)	11.4 (0.5)	0.10 (0.01)	0.10 (0.01)
	20	14.6 (0.6)	29.6 (4.7)	4.5 (0.3)	13.9 (0.4)	0.18 (0.02)	0.09 (0.01)
	30	14.0 (1.7)	27.0 (9.5)	4.9 (1.2)	12.2 (1.8)	0.24 (0.05)	0.29 (0.03)
Flowering	Control	20.1 (3.0)	49.3 (5.0)	21.1 (1.7)	31.9 (4.3)	0.08 (0.01)	0.04 (0.01)
	10	17.3 (4.6)	47.6 (13.3)	21.3 (3.7)	28.5 (8.0)	0.10 (0.02)	0.13 (0.02)
	20	19.3 (2.5)	38.3 (9.0)	19.9 (0.9)	25.9 (4.8)	0.11 (0.01)	0.14 (0.01)
	30	17.3 (4.6)	38.6 (14.3)	21.8 (4.8)	25.6 (6.6)	0.17 (0.28)	0.20 (0.01)
Maturity	Control	21.0 (6.0)	67.0 (4.0)	18.4 (4.4)	40.3 (8.7)	0.06 (0.02)	0.06 (0.01)
	10	20.0 (2.0)	69.3 (9.7)	21.5(5.5)	48.3 (8.3)	0.10 (0.03)	0.09 (0.01)
	20	23.0 (6.6)	60.6 (6.7)	16.3 (5.8)	46.5 (18.4)	0.12 (0.02)	0.10 (0.01)
	30	22.0 (2.0)	68.0 (9.6)	19.0 (5.6)	42.5 (7.2)	0.18 (0.03)	0.12 (0.01)

The values in parenthesis are the standard deviation ($\pm$ SD). All values are significantly different at $P>0.05$ level

Table 3: General properties and heavy metal contents of rice husk and coco peat media

Media	EC Ms/cm	pH*	Metal ion (ppm)							Reference
			Mg	Ca	Fe	Cu	Cd*	Mn	Zn	
Rice husk	0.83	6.8	41.3	43.5	33.5	1.9	0.06	5.4	1.4	26,27
Coco peat	1.5	6.6	0.19	4.7	0.15	0.03	0.05	0.02	0.05	28

*Present study

Table 4: Effect of planting media on the micronutrients concentration in chilli fruits.

Media	Treatment (ppm)	Micronutrients					
		Mg	Ca	Mn	Fe	Cu	Zn
Rice Husk	Blank	1.49	3.28	0.19	7.23	1.16	0.51
	30	0.31	1.24	0.27	1.07	0.04	0.55
	P-value	0.05	0.05	0.82	0.05	0.05	0.82
Coco Peat	Blank	1.50	7.65	0.21	2.12	0.27	0.47
	30	0.33	1.32	0.18	1.11	0.86	0.60
	P-value	0.05	0.51	0.12	0.27	0.51	0.12

increasing of Cd dose from 10 to 30 ppm resulted in a decrease in plant height that was grown in rice husk media. No remarkable effect was observed in coco peat media. Study by Peralta *et al.* [25] documented that increasing Cd concentration in the growing media will reduce the shoot growth of alfalfa plants.

4. Conclusion

Planting media has a significant effect on the uptake of cadmium by the chilli plant. Rice husk media has less impact on Cd absorption compared with coco peat media. The results showed that the concentration of cadmium in chilli fruits in both media was above the safety limits of the FAO and WHO standard (2001), (0.05 ppm). Results also concluded that increasing level of Cd in planting media will affect the micronutrients concentrations in the chilli fruits that grown in rice husk. Therefore, affecting the quality and production of the chilli plants.

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